Estimating Wolverine Population Size
Using Quadrat Sampling of Tracks in Snow

Howard N. Golden, Alaska Department of Fish & Game
Michael I, Goldstein, USDA Forest Service, Juneau
John, M. Morton, Kenai National Wildlife Refuge
Ian D. Martin, Kenai Fjords National Park
Aaron J. Poe, Chugach National Forest

Wolverine Survey Plan for Upper Turnagain Arm and Kenai Mountains, Alaska

Interagency Collaborative Project

October 2003

Participants:
Howard Golden, Alaska Department of Fish and Game
Mike Goldstein, Chugach National Forest
Aaron Poe, Chugach National Forest
John Morton, Kenai National Wildlife Refuge
Ian Martin, Kenai Fjords National Park
Jeff Selinger, Alaska Department of Fish and Game
Rick Sinnott, Alaska Department of Fish and Game

Other Personnel:
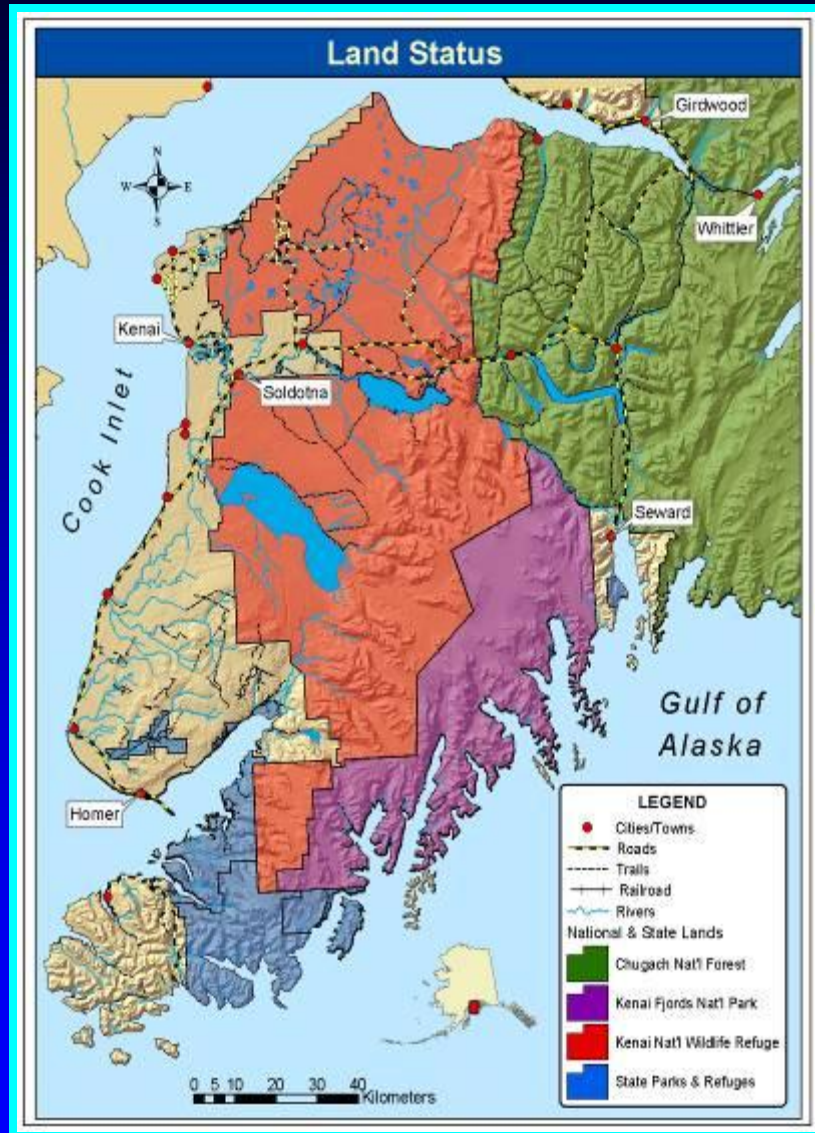Mary Ann Benoit, Chugach National Forest
Jesse Coltrane, Alaska Department of Fish and Game
Rick Ernst, Kenai National Wildlife Refuge
Thomas McDonough, Alaska Department of Fish and Game
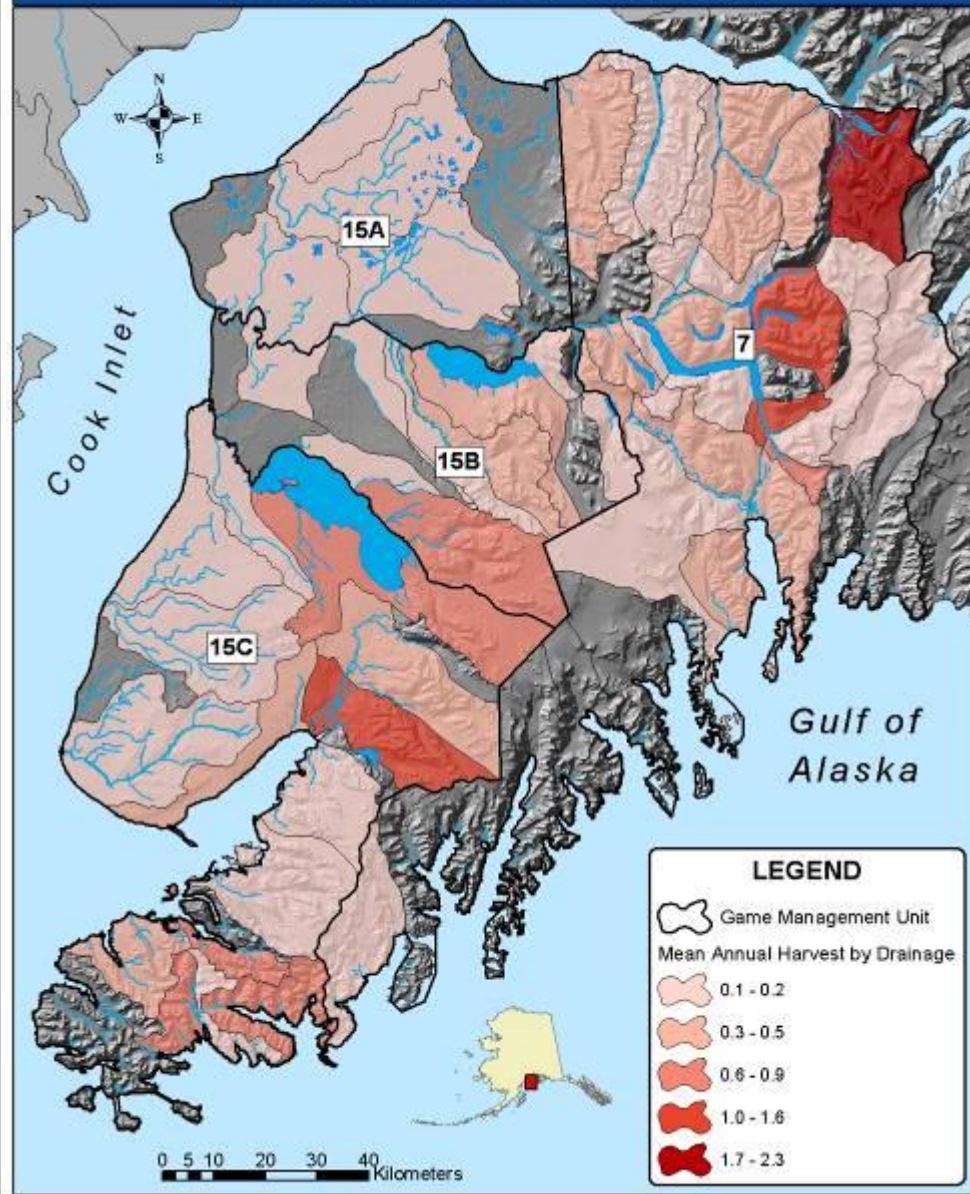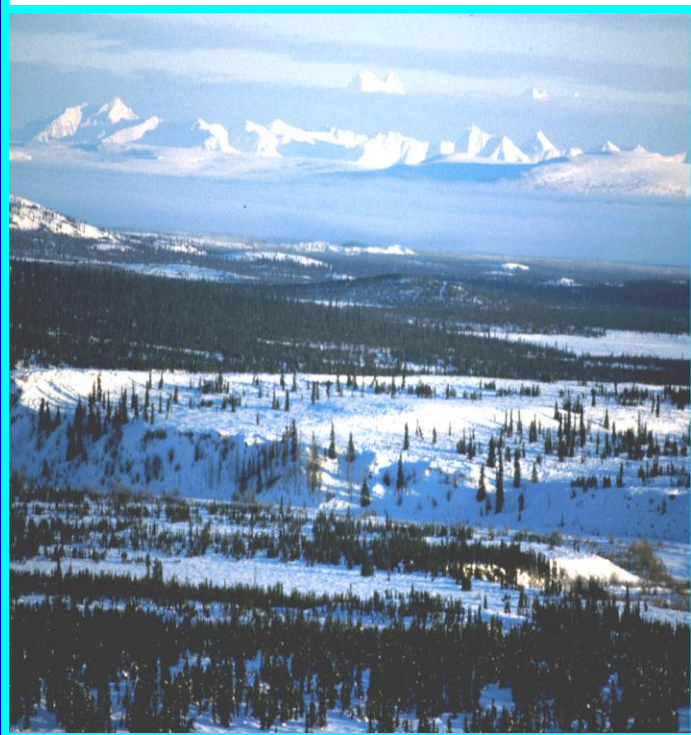Liz Solomon, Alaska Department of Fish and Game

Kenai Peninsula, Alaska

Cook Inlet

MOUNTAINS

KENAI

HARDING ICEFIELD

Gulf of Alaska

Turnagain Arm

Kachemak Bay

0 5 10 20 30 40 Kilometers

Land Status

Cook Inlet

Girdwood

Whittler

Kenai

Soldotna

Seward

Gulf of Alaska

Homer

LEGEND
- Cities/Towns
- Roads
- Trails
- Railroad
- Rivers

National & State Lands
- Chugach Nat'l Forest
- Kenai Fjords Nat'l Park
- Kenai Nat'l Wildlife Refuge
- State Parks & Refuges

0 5 10 20 30 40 Kilometers

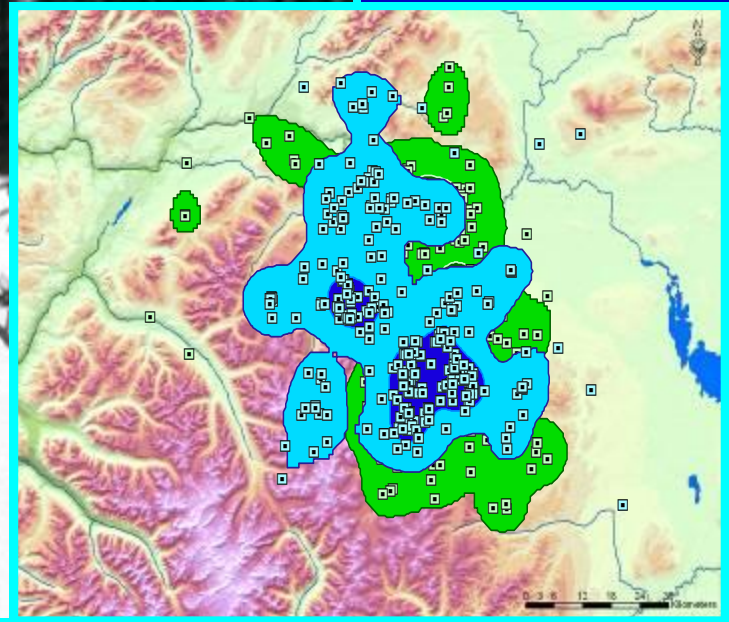# Outdoor Recreation

Wolverine Harvest: 1984–2001

Density Estimation

Capture & Home Range Estimates
(Wolverines/1000 km^2)

- 15   northwest Montana
- 7–21 arctic Alaska
- 5.6   southern Yukon
- 4–5   central Idaho

No estimates of variance

TIPS Surveys

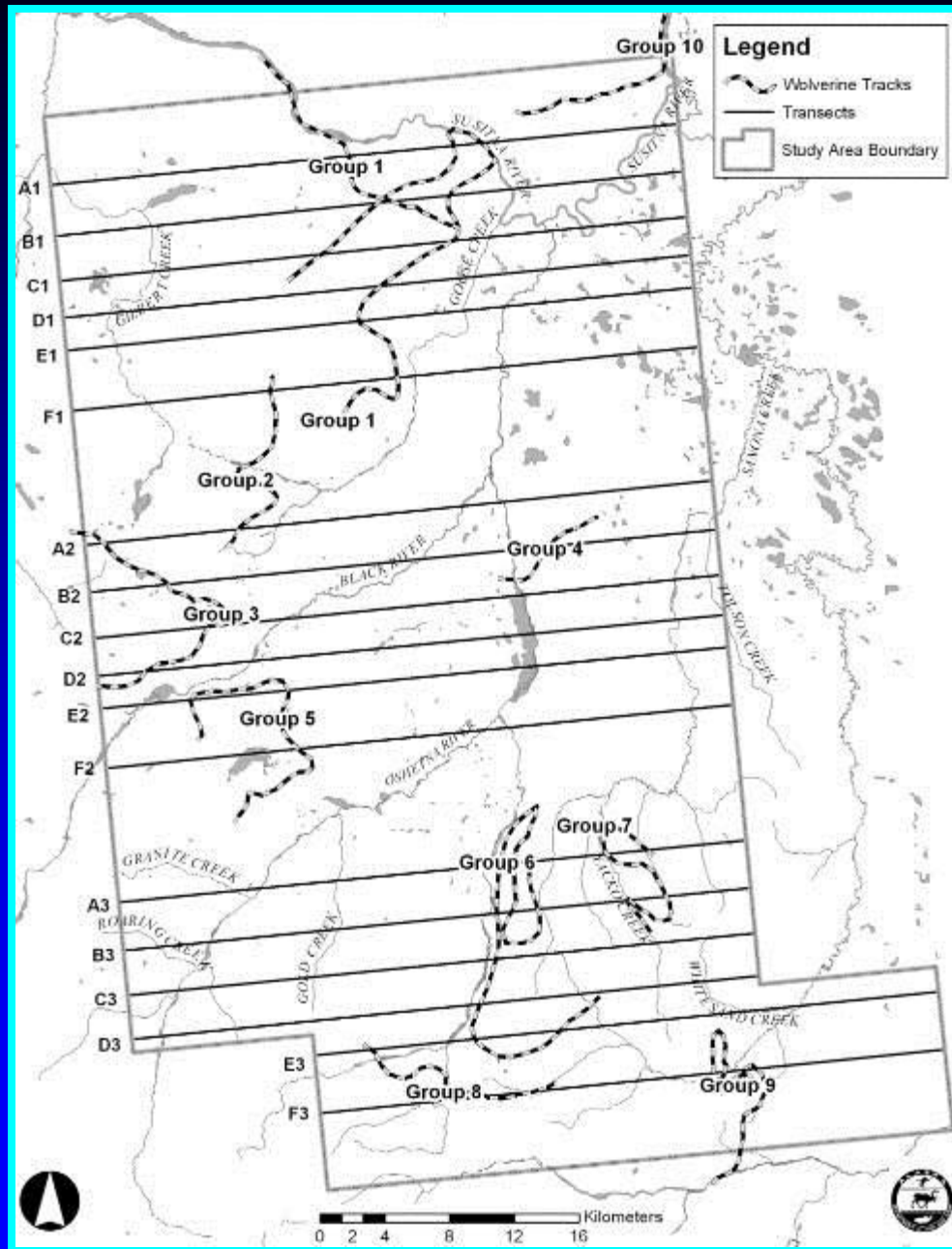## Transect Intercept Probability Sampling

Estimated Densities (± SE)
(Wolverines/1000 km^2)

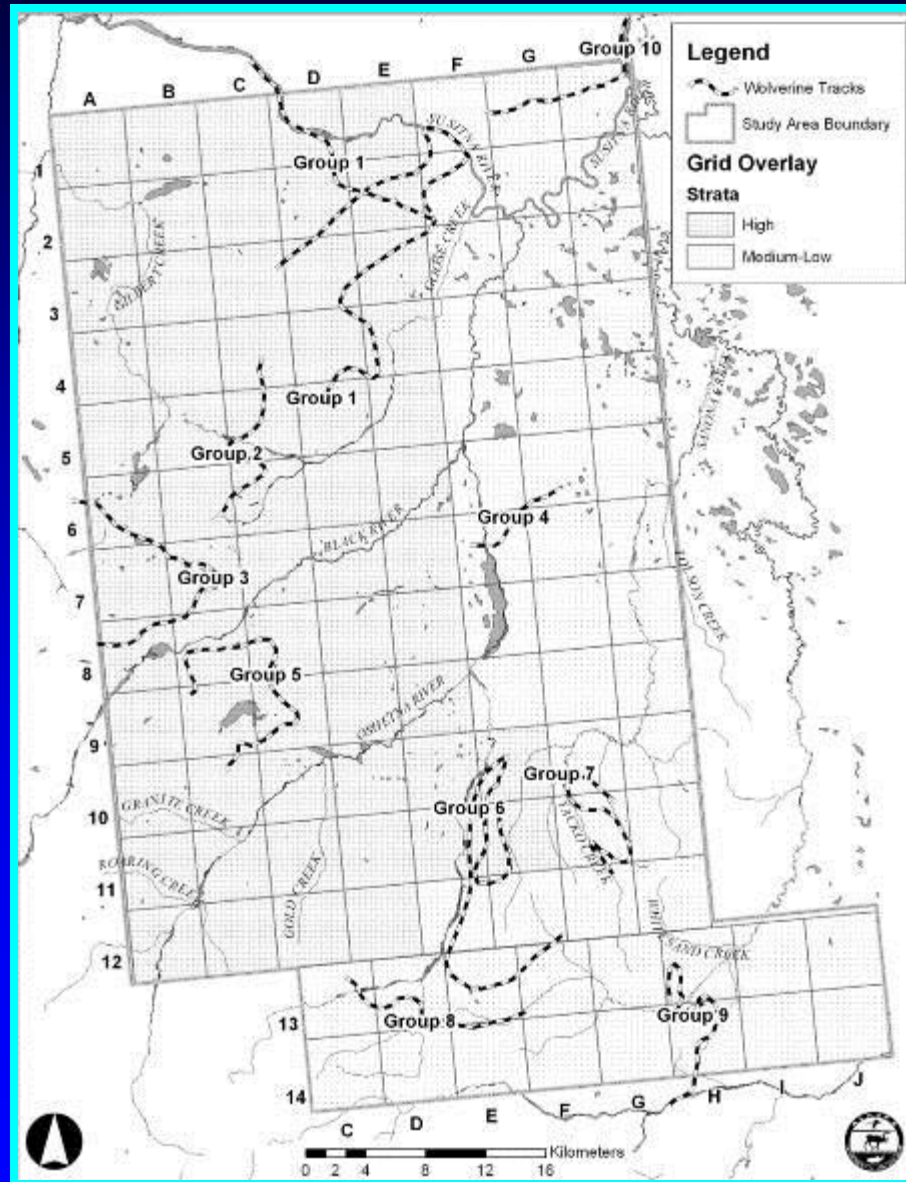5.2 (1.1) Chugach Mtns
CV = 20%

4.7 (0.6) Talkeetna Mtns
CV = 13%

Problems:
- Hard to survey in steep terrain
- Requires very good conditions
- Designed for 1-day survey
- CVs higher than preferred
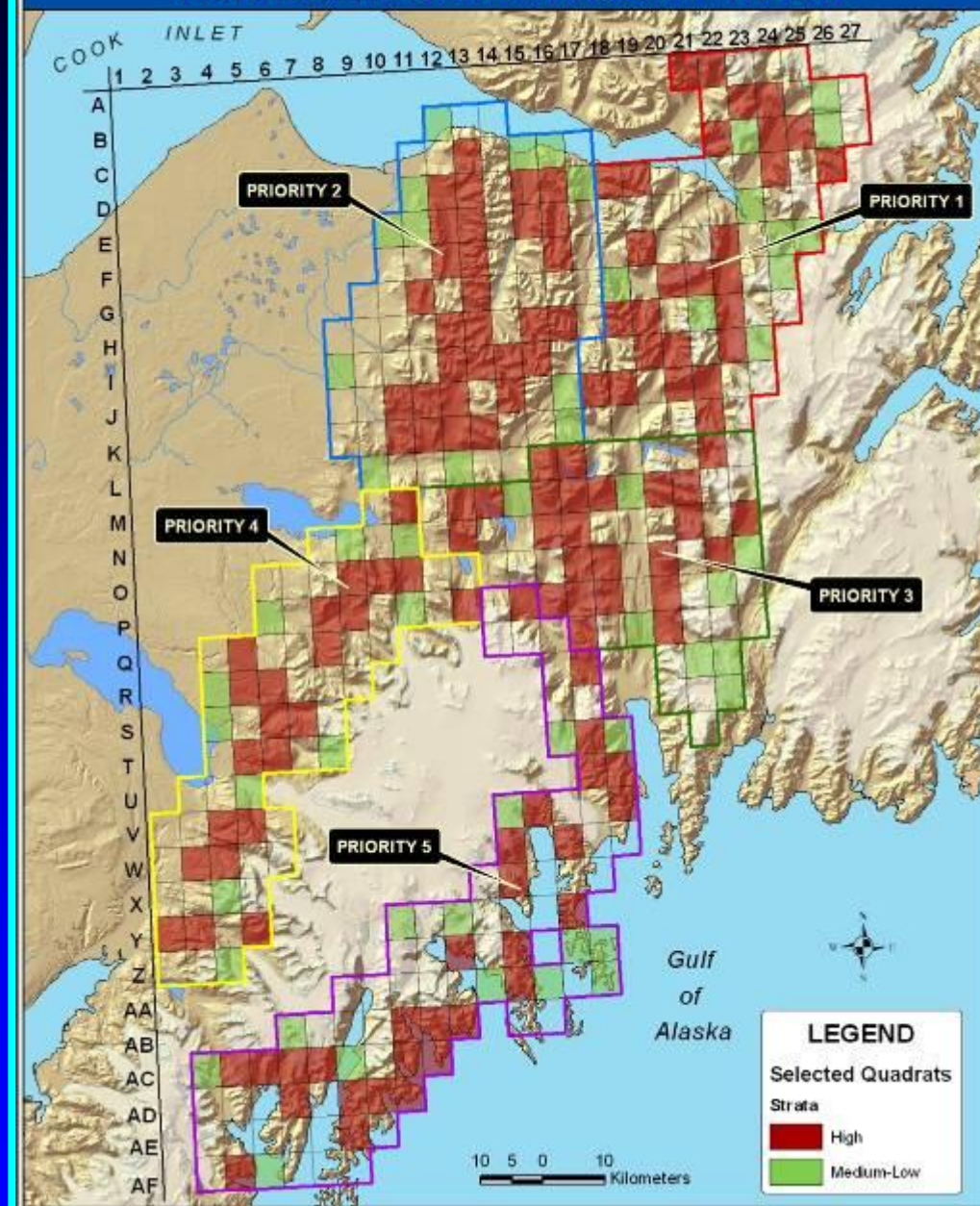
SUPE Surveys
Sample Unit Probability Estimator


Stratified network sampling design

Assumptions:

- All animals of interest move during study

- Tracks are readily recognizable from air

- Tracks are continuous

- Movements are independent of sampling process

- Pre- and post-snowstorm tracks can be distinguished

- Tracks in the searched sample units are not missed

- Tracks can be followed to determine all SUs containing tracks

- Group size is correctly enumerated

Stratification of Quadrats & Selection of Sample Units
For Chugach National Forest and Kenai Fjords National Park
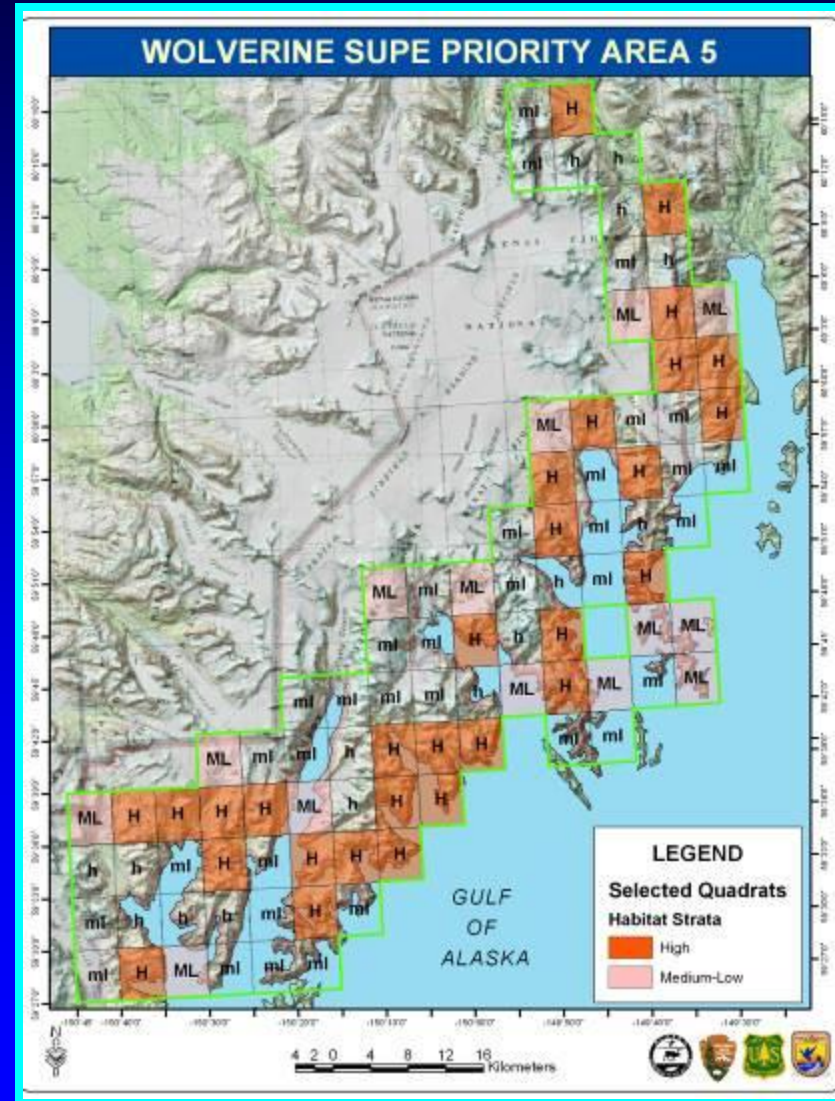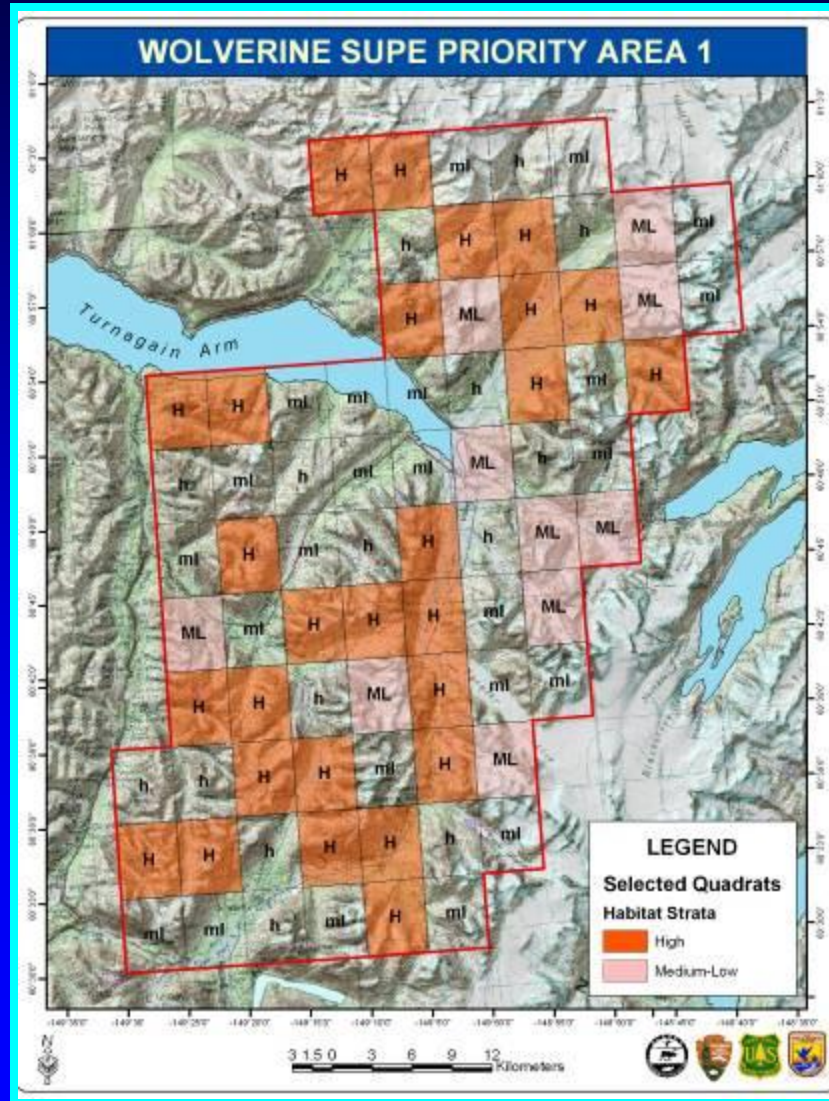
Sample Unit Distribution & Sample Effort Allocation
For Planned SUPE Survey of All Areas (9,900 km^2)

Strata	Total Quadrats	Sample Units	Sampling %
High	207	134	65
Medium-Low	179	54	30
Total	386	188	49

Tracking

Data Collection

WOLVERINE SUPE FORM

Sheet _____ of _____

Date _____ Area _____ Aircraft Hours _____

Pilot _____ Observers _____

Snow Age	Snow Cover	Light Type	Light Intensity	Predominant Habitat in SU	Survey Rating
1. 1-2 days	1. Complete	1. Bright	1. High	1. OPEN lower elev. shrubs/wetland	A. Excellent
2. 3-4 days	2. Some low veg showing	2. Flat	2. Medium	2. DECIDUOUS FOREST	B. Good
3. 5-6 days			3. Low	3. MIXED FOREST	C. Fair
4. 7+ days	3. Bare ground showing			4. OPEN CONIFEROUS FOREST	D. Poor
				5. DENSE CONIFEROUS FOREST	
				6. SUB-ALPINE FOREST	
				7. BURN	

SAMPLING ORDER	1	2	3	4	5	6	7	8	9	10
SU ID										
SNOW AGE										
SNOW COVER										
LIGHT TYPE										
LIGHT DENSITY										
HABITAT TYPE										
SURVEY RATINGS										
START TIME										
STOP TIME										
COMMENTS										

GROUP INFORMATION

Ref. #	SU track 1st spotted	Time 1st spotted	SUs with tracks	SUs with wolverines	Time tracking ended	Group Size	In/Out	GPS Coordinates/Comments

WOLVERINE SUPE INSTRUCTIONS

OBJECTIVE — For every **selected** sample unit (usually 5×5 km or 3×3 mi squares) we must determine if a wolverine group (≥ 1 wolverine) made **fresh tracks** in the sample unit (SU). Once fresh tracks are found in a selected SU, they are followed (forward and backward) to determine which other sample units they entered and the number of wolverines in the group. To obtain a good population estimate, it must be assumed that: (1) fresh tracks in selected SUs are not missed, and (2) all SUs containing fresh tracks enumerate the number of wolverines.

FRESH TRACKS — Tracks made since the last snow fall (or major wind storm) and new enough to track (usually < 2 days old).

OLD TRACKS — Tracks that are not "FRESH TRACKS."

SURVEY PROCEDURE —

1. Divide the selected sample units (SUs) among the pilot/observer teams, and have all teams work through their SUs by traveling in the same general direction to maintain safe spacing among planes.

2. It is optimal to survey from SuperCubs at 95–130 kph (60–80 mph) and at 90–150 m (300–500 ft) above ground level (agl).

3. Spend 12–13 min/selected SU. Use more time if necessary to meet the above objective (e.g., in forested SUs).

4. Once a fresh wolverine track is observed in the selected SU, back-track it to the location were the track would be considered too old to follow if first observed at that point, and forward-track it to the location of the wolverine. Record the track location on the map, and note the time the track was found, and the SUs containing the track on the survey form. It is also a good idea to record the track with a GPS using the unit's tracking mode set to update the signal every second.

5. SAFETY — Broadcast your flight path to other pilots while following tracks.

6. For all wolverine observations, note the location (i.e., SUs containing the track), direction of travel, number of wolverines, and time the animal was observed on the survey form. Mark the location of the wolverine on the map. Record GPS coordinates of the beginning and end of each track trail.

7. When backtracking, if localized environmental conditions have caused the track to be classified as "OLD", quickly search for undetected "FRESH" track segments (> 0.8 km or 0.5 mi) farther down the trail to ensure that there are no unrecorded SUs with fresh segments from this animal. Use dotted lines to connect the fresh segments on the map. On the data form, only record SUs with **fresh track** locations.

8. Once tracking has been completed, quickly survey the remainder of the **selected** SU to determine if additional wolverine tracks are present. If any are found, treat as above (#4, #5, & #6), and note whether or not the tracks connected with other tracks. Tracks that do connect will be treated as 1 animal for survey purposes, unless they can be separated temporally.

9. If fresh tracks go outside the study area, follow them to determine if more than half of their length lies outside of the study area; if so stop tracking the animal and record it as "OUT" on the data form.

10. **Alternative Method:** Follow tracks outside the study area to the wolverines. Draw out the track system in sufficient detail to determine the proportion of the track length in and outside of the study area. Apply this proportion to group size to determine an "effective study area group size." Use this value in the SUPE calculations to obtain the population estimate. Pick a method and use for all groups.

* Note: When testing to measure the accuracy of the SUPE for wolverines where daily replicate surveys of the same SUs are being conducted, take care to record only tracks that are new since the previous day's surveys.

2004 Wolverine SUPE Priority Areas & Surveyed Quadrats
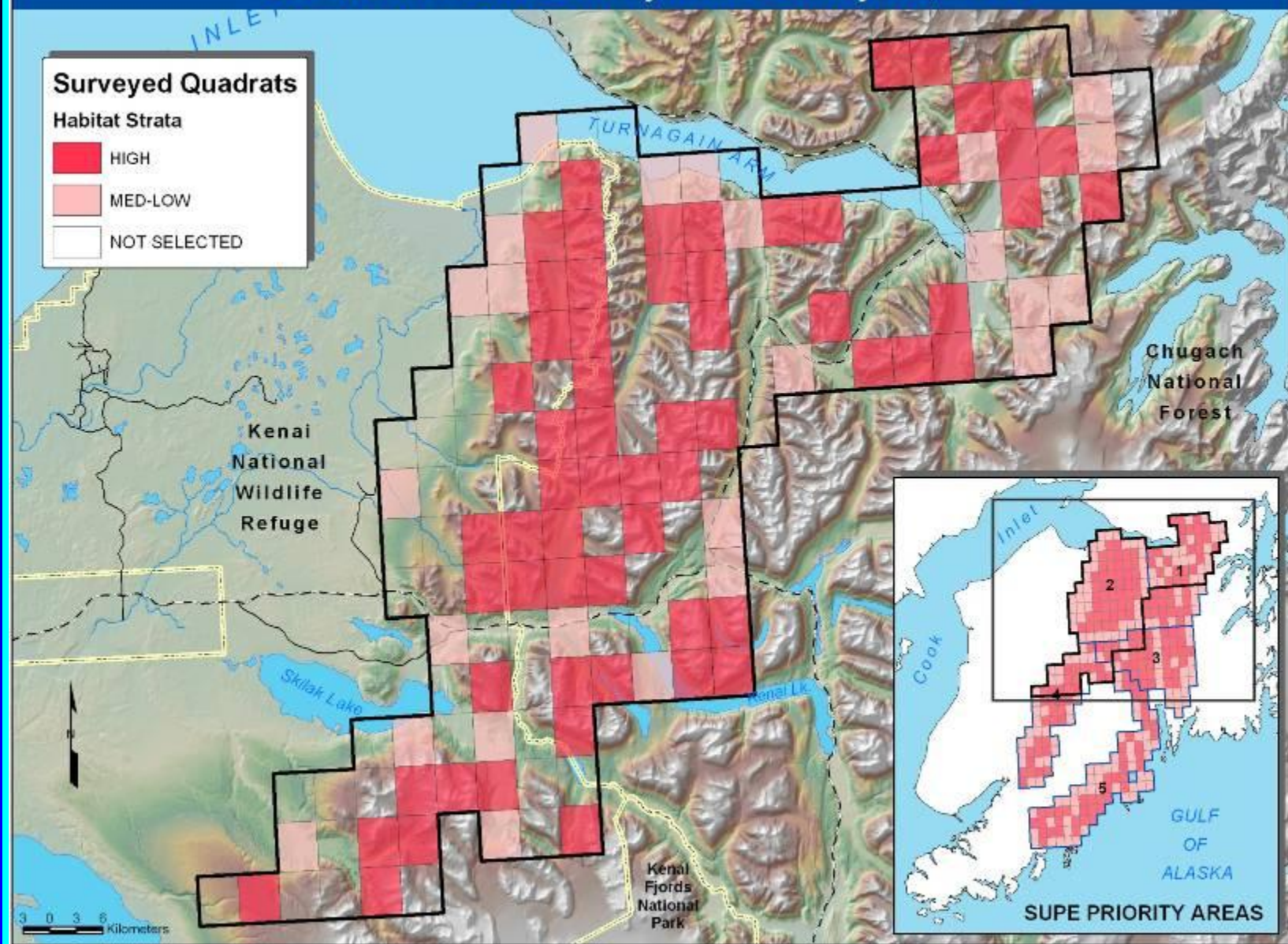
Sample Unit Distribution & Sample Effort Allocation
For SUPE Survey, 6 & 17 March 2004 (4,340 km^2)

Survey flown with 5 pilot/observer teams on 6 March & 2 teams on 17 March

Total flight time = 32.5 hours

Strata	Total Quadrats	Sample Units	Sampling %
High	94	62	66
Medium-Low	77	25	32
Total	171	87	51

2004 Wolverine SUPE Priority Areas and Results
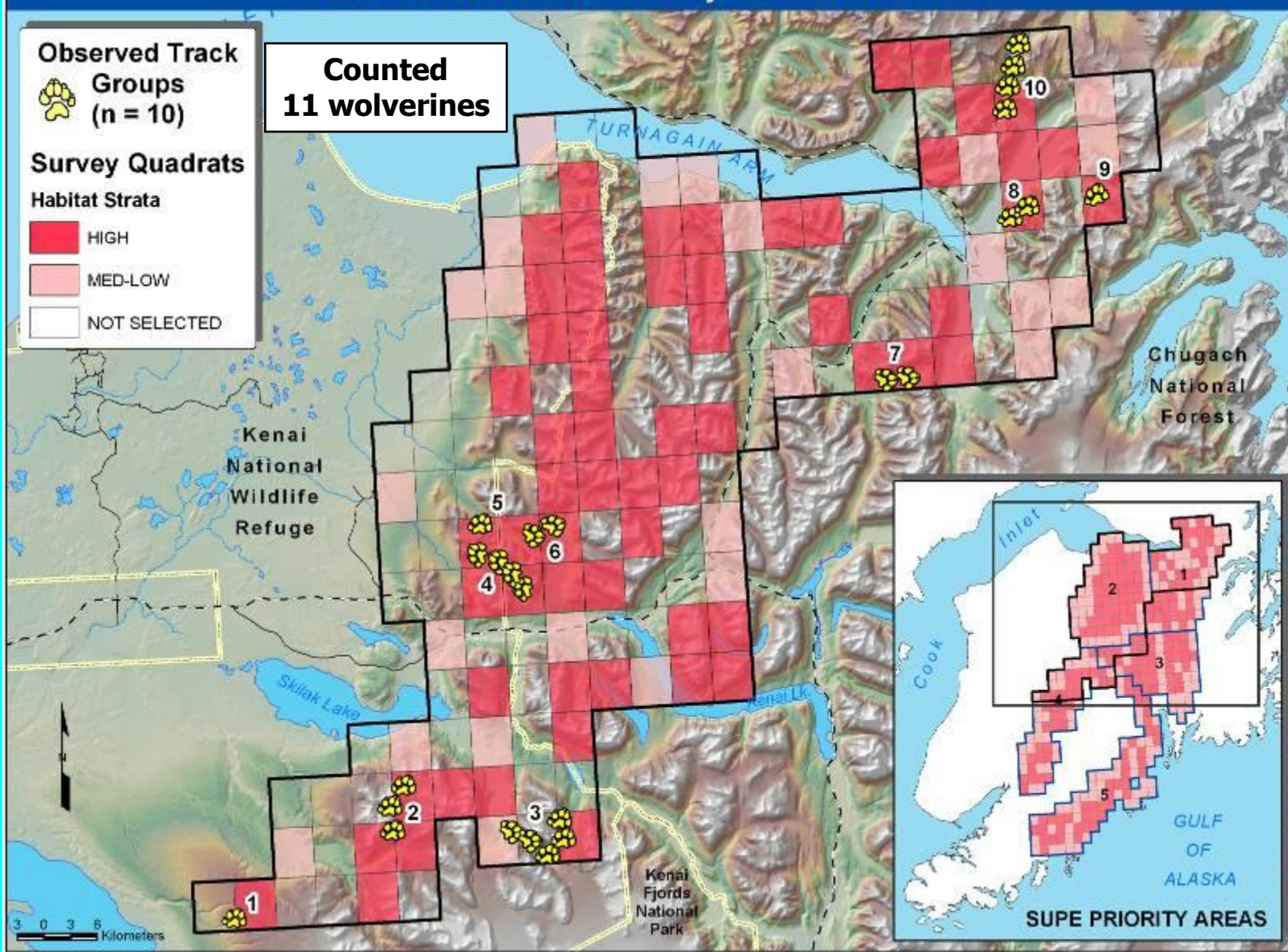
Population Estimate

$$\hat{T}_y = \sum_{u=1}^{r} \frac{y_u}{p_u}$$

Variance

$$Var(\hat{T}_y) = \sum_{u=1}^{r} \frac{(1-p_u)}{p_u^2} y_u^2 + 2\sum_{u=1}^{r}\sum_{v=u+1}^{r} \left(\frac{1}{p_u p_v} - \frac{1}{p_{uv}} \right) y_u y_v$$

SUPEPOP at ftp://ftpr3.adfg.state.ak.us/MISC/PROGRAMS/SUPEPOP/

SUPE Survey Results for March 2004

Parameter	Estimate	SE	80% CI	± %	90% CI	± %
Population size	12.80	1.54	11.00, 14.93	16.65	11.00, 15.62	22.07
Density #/1000 km^2	2.95	0.36	2.53, 3.44	16.65	2.53, 3.60	22.07

Coefficient of Variation = 12%

To be continued -- Spring 2005